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Water Conservation Planning Workshop
Before the Well Runs Dry: A Workshop on How to Design a Local Water Conservation Plan

Barry Lawson Associates, Inc.
Boston, MA

Prepared for

Missouri Basin States Association
Omaha, NE

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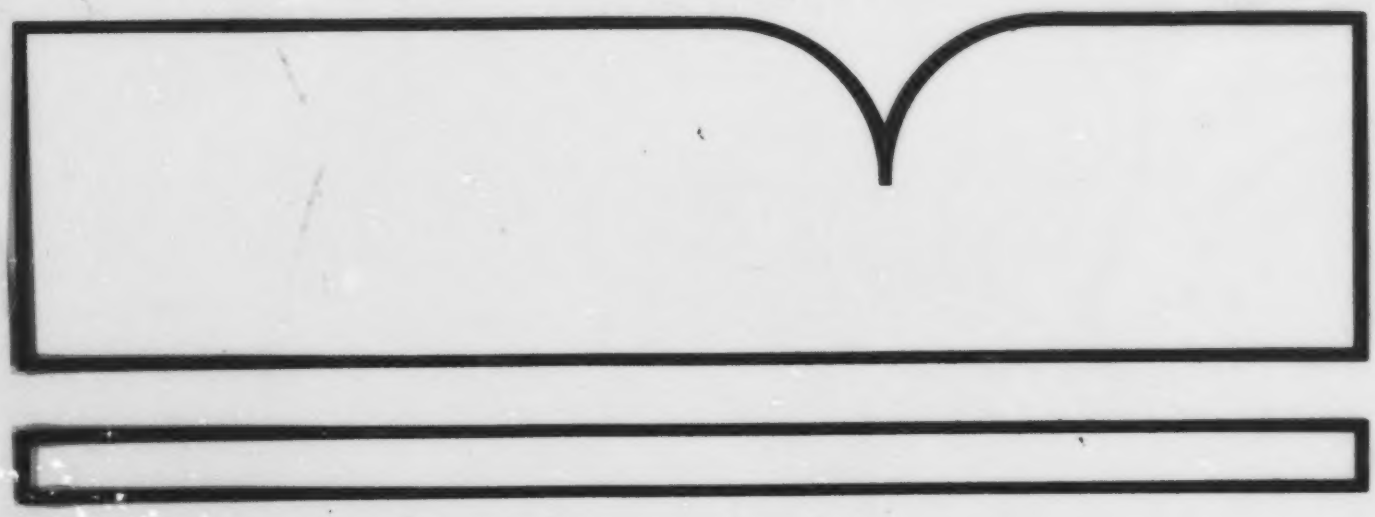

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WATER CONSERVATION PLANNING WORKSHOP

Sponsored by:

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The Missouri Basin States Association is a non-profit organization incorporated in the State of Nebraska on September 18, 1981. Its stated purpose is to ". . . conduct, encourage and participate in activities which promote interstate coordination of water resources management within the Missouri River Basin . . . ." The Association is governed by a 20-member Board of Directors composed of two members from each of the 10 states within the Missouri River Basin (Colorado, Iowa, Kansas, Minnesota, Missouri, Montana, Nebraska, North Dakota, South Dakota and Wyoming).

Barry Lawson Associates, Inc., a Boston-based consulting firm, conducts economic and planning analyses, conducts workshop and training programs and prepares information and audio visual materials. Among its nationwide programs are several designed for individual communities, states, regional commissions and federal agencies in the water resource, energy and environmental fields.

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WATER CONSERVATION PLANNING WORKSHOP

AGENDA

8:30 a.m.	Registration and Coffee
9:00 a.m.	Welcome and Introduction
9:15 a.m.	Water Resource Limitations in the Area
9:30 a.m.	Practical Considerations in Developing a Water Conservation Plan
9:50 a.m.	Case Study Exercise - Step One
10:20 a.m.	The Seven-Step Approach - An Illustrated Lecture
11:20 a.m.	Case Study Exercise (continued) - Steps Two through Four
12:00 noon	Lunch (to be served)
1:00 p.m.	Case Study Exercise (continued) - Steps Five through Seven
2:00 p.m.	Review of Water Conservation Plans
2:45 p.m.	Break
3:00 p.m.	Local Application of the Seven-Step Approach
3:30 p.m.	Wrap-up and Evaluation
3:45 p.m.	Adjourn

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LECTURE NOTES:

Resource Limitations

Practical Considerations

The Seven-Step Approach

WATER RESOURCE LIMITATIONS IN THE AREA

A. Demand Picture

1. Water Demand - Population by Area

2. Water Use in Area, 1980

   a. Agricultural
   b. Municipal and Industrial
   c. Rural Domestic
   d. Energy
   e. Other

3. Projected Demand

B. Supply Picture

1. Water Supply - Surface/Groundwater

2. Restrictions and Limitations

3. Future Supply Sources

C. Summary - Major Issues

1. Accommodating Long-term Growth

2. Assessing Supply Availability

3. The Quality of Supplies

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PRACTICAL CONSIDERATIONS IN DESIGNING A CONSERVATION PLAN

A. What is water conservation and under what conditions should it be considered?

   1. Supply/Demand information

   2. Projections

   3. Monitoring

B. The determinants of the "cost" of a local water conservation program

   1. Type of problem

   2. Type of program

   3. Available resources and the revenue problem

   4. Risk - the errors of omission versus errors of commission

   5. Cost effectiveness

C. Some major challenges to address:

   1. Overcoming institutional/community inertia

   2. Recognizing the political realities and overriding issues

      a. growth vs. no growth
      b. the revenue picture

   3. Achieving a balance among program criteria

   4. Knowing and predicting price elasticities

   5. Dealing with the press and the public

D. Keys to success

   1. Insuring community understanding

   2. Community leadership and agency coordination

   3. Acquiring the short- and long-term perspectives

   4. Preparing a plan or strategy based on specific objectives

   5. Monitoring continually

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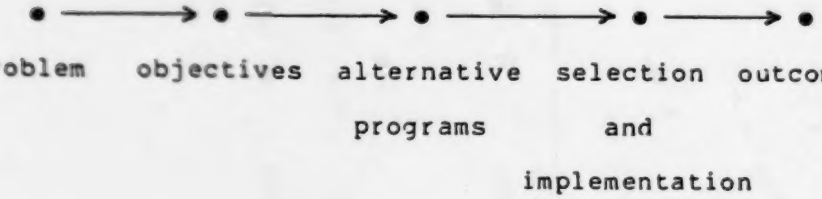
WATER CONSERVATION LECTURE

The planning approach is designed to help you to:

- consider the full range of options
- evaluate the advantages and disadvantages of various options
- assess the potential impacts of each option on your utility, the users and the community

We can look upon the seven-step approach as a typical planning model:



Now, modifying this basic planning model to the area of local water conservation, makes it just a bit more complicated, but essentially a special case of this model, as is shown on the chart on the following page.

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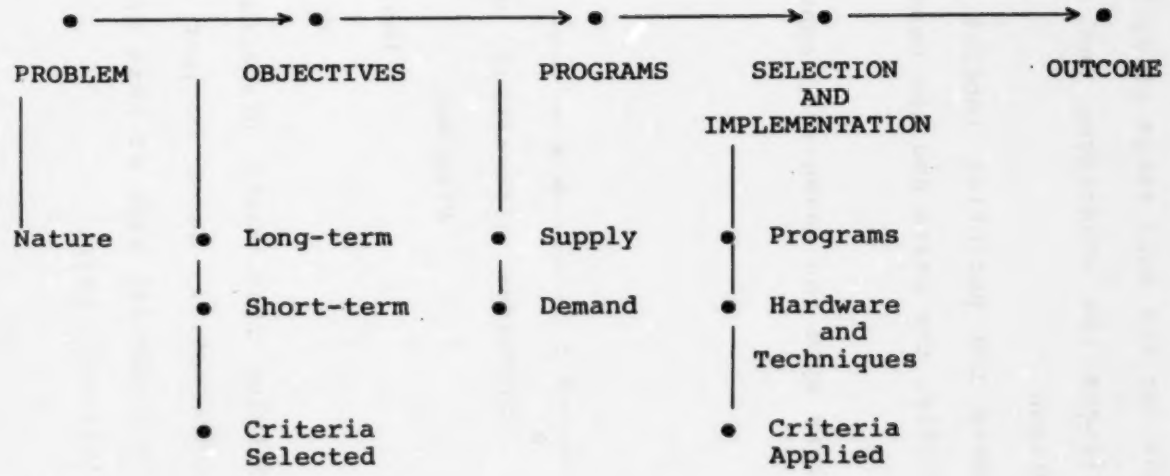
PLANNING MODEL EXPANDED FOR APPLICATION IN WATER CONSERVATION



STEPS: 1 → 2 — 3 — 4 → 5 — 6 — 7 →

And all of this occurs in an environment of available resources (e.g., money, people and leadership) and limiting constraints (e.g., weather and climate, economic conditions). And, as is evident, this model, as presented, is process-oriented, not necessarily time-oriented. In a few minutes, when we get to the lecture on the seven steps, you will see that the seven steps in the methodology correspond to the specific steps in the generalized planning model for water conservation.

Turn now to the slides for a preview of this seven-step methodology.

The first step is to analyze the problem and establish a conservation goal. There are three aspects of this first step:

1. Evaluating whether the community has an average demand problem or peak demand problem;
2. Establishing the percent reduction needed; and
3. Deciding whether the problem is long-term or short-term.

The next step requires an analysis of whether your goals can best be met at the supply end--making improvements in the water supply system--or in the demand or consumption side of the system, or a combination of both.

The third step calls for you to analyze the net cost and impacts of various management options.

On the supply side, analyze five management programs:

- Metering and meter maintenance
- Leak detection and repair
- Pressure reduction
- Watershed management
- Evaporation suppression

If you choose to work on the demand side, the third step in the approach calls for analyzing the impacts of one of three tools to reduce water consumption:

- Price - an economic incentive, encouraging users to conserve to save money
- Regulation - a legal incentive which requires users to conserve to comply with the law
- Education - a voluntary incentive which seeks to change behavior or attitude through information and explanation

You may choose to mix price, regulation, and education to develop a successful program. Experience has shown that education plays a crucial role in raising the effectiveness of the other incentives, especially in a crisis situation.

It is important to explain the situation to consumers, describe the action being taken or proposed, and explain what consumers should do and why these actions are necessary.

In Step 4, consider ways to avoid or minimize any adverse impacts evident in the supply and demand management programs you are reviewing.

In Step 5, choose and design the specific supply and/or demand management programs you will use.

For demand management programs, this includes choosing new water rates, water use restrictions, or educational materials.

In Step 6, choose devices -- the actual hardware or techniques -- that physically reduce water use.

For supply management, the hardware/techniques include the five programs already mentioned. For demand management, they include:

- water saving fixtures
- reuse/recycle systems
- user habit changes

Supply devices can be used alone, or in conjunction with a demand program.

In the final step, combine the results of your various analyses and decisions in the form of an implementable water conservation plan.

O.K. Let's look at the seven-step program in depth.

THE SEVEN STEP APPROACH IN DETAIL

STEP 1, IDENTIFY PROBLEM/ESTABLISH A CONSERVATION GOAL. This is the key to the planning procedure because all decisions are based on whether the various alternatives under consideration can meet the goal.

The goal is defined by three factors or needs:

- peak and/or average use has to be reduced
- high or low percentage reduction in use is needed, and
- short- or long-term time span

Peak use refers to the summer mean daily use caused by outside uses. Average use refers to the annual average use.

When stating percentage reductions, 1-10% is considered a low percentage reduction, and over 10% is considered high.

A short-term time span is approximately one year or less, while long-term is a year or more.

At this point, it is essential to raise the question about the criteria to be applied. As you pursue your goals, achieving a balance among the four criteria (efficiency, effectiveness, equity and enforceability) - a balance which is acceptable to all parties - is a major challenge and it must be dealt with squarely.

STEP 2, CONSIDER SUPPLY AND DEMAND MANAGEMENT APPROACHES

This step is conceptually straightforward. Yet it requires considerable analysis and planning.

The goal of supply management is to improve efficiency and reduce waste within the production and delivery system. It is often the best long-term option because conservation goals are met without depending on water users. While this is standard operating procedure for a well-run utility, sometimes a water supply problem can be solved through better management alone.

Supply management is best used for long-term, low percent reduction goals. It may be useful for short-term goals if your system has not been adequately maintained over the years. It may also be useful for peak use reduction if the problem is caused by inadequate storage or pipe capacity.

The advantages of supply management are:

- the program is under your direct control
- revenues can increase
- slack is maintained in system capacity

Among the disadvantages of supply management are:

- large capital expenditures are usually required
- the options are labor intensive
- a long lead time is needed

Your analysis may require much time or little time, depending upon past studies and experience. Supply management yields long-term improvements in the system. Costs are high, though the "crisis mentality" created during a period of water shortages may help to build a potential constituency in favor of long-term changes, even if they prove costly.

If supply management alone is not adequate to achieve the conservation goal established in Step 1, then you'll want to consider demand management. Demand, or consumption, management requires water users to modify their behavior and reduce consumption in a home or business setting. It has the potential to achieve any conservation goal.

In general, the advantages include:

- Versatility
- Low expense (potential)
- Less labor intensive
- More rapid implementation

The disadvantages include the possibilities that:

- Revenues may drop
- Results depend on users' cooperation
- Political support required
- Opposition or resistance from users

STEP 3, ANALYZE THE COST EFFECTIVENESS AND THE IMPACTS OF VARIOUS SUPPLY AND DEMAND MANAGEMENT OPTIONS

For supply management, there are five programs:

- Metering and meter maintenance
- Leak detection and repair
- Pressure reduction
- Watershed management, and
- Evaporation suppression

This type of supply side analysis is not unique to water conservation. Many of you do this as a matter of good management practices. What is unique, however, is a recognition of how to use improved supply management as a way to meet water conservation goals.

Metering

Metering itself does not reduce water consumption. It provides an accurate accounting of all the water used throughout the system. This information is needed for planning leak detection and repair programs, pricing programs, and other conservation efforts. If the utility decides to install new meters for all

its users, and in conjunction, implements an appropriate water rate, a long-term reduction in water consumption can be realized.

Leak Detection and Repair (LD&R)

LD&R can substantially reduce water waste within the system. LD&R also includes an analysis of unaccounted-for water.

Some categories of unaccounted-for water include abandoned services, inaccurately metered water, illegal hook-ups, and defective hydrants.

There are two basic methods for conducting surveys: if your system is losing water primarily through leaks, a system scan would be most effective; if your system is losing water through illegal hook-ups, or meter under-registration (e.g., unaccounted-for water), a water audit would be most effective.

Leak detection and repair programs are almost always cost-effective. They are best for long-term, low percent reduction goals. If the system has not been well maintained, leak detection might achieve a high percentage reduction goal if used as a conservation technique.

Pressure Reduction

Consider pressure reduction if there are a significant number of areas where pressure is high (80 lb/sq in. or greater).

Pressure-reducing valves installed in street mains or individual services can reduce waste simply by reducing the amount of water passing through the system. Pressure reduction is used for meeting long-term, low percentage reduction, average use goals.

Watershed Management

Watershed management is used primarily to protect or increase water flows to the supply and to protect ground water sources. Techniques include: (1) forestry management (thinning forests in the watershed); (2) zoning ordinances to prohibit inappropriate land uses within the recharge area; (3) purchasing surrounding watershed land to maintain it under your control; and (4) sub-division regulations which allow development to proceed in a manner which does not harm the watershed. Watershed management is most useful for meeting long-term, low percentage reduction, average use goals.

Evaporation Suppression (reservoir covers)

Evaporation suppression is only useful when evaporation is responsible for significant water loss (greater than 10%). It is used in more arid places.

The impact analysis for each supply management program entails a review and analysis of the following impacts:

- Financial and economic
- Technical and environmental, and
- Legal and institutional.

Handbook Figure 3.2 details a set of impacts that may occur as a result of undertaking the different supply management programs.

Use the list of impacts as a guide, and concentrate only on those that are relevant to your setting.

For demand management programs, analyze the cost effectiveness and the impacts of various demand management options.

In demand (consumption) management programs, you have a choice of three tools to encourage users to reduce their use:

- Pricing
- Regulation, and
- Education

In many cases, you will combine the three tools.

All three programs can be relatively inexpensive to implement.

Pricing - If a pricing program is carefully designed, it can generate excess revenues while it encourages use reductions. Therefore, it should be considered as part of many conservation programs.

Pricing is best used for long-term, low percent reduction goals.

The costs of a pricing program are mostly one time costs. These costs will be for a rate survey, or cost of service study, possibly costs to institute a new billing system, and, if regulated, costs for an attorney if you have to present your new rate before a public body.

The major disadvantage to pricing is user opposition, especially from industry and local government.

Regulation - This program can be used to achieve any conservation goal. It is most effective for short-term, high and low percentage reduction goals and long-term, low percentage reduction, average or peak goals. Regulation can be quickly implemented and can achieve immediate results.

Costs to implement regulation are limited to costs of enforcement. If you do not have the authority and/or manpower for enforcement, you may have to secure the assistance of government officials.

The major disadvantages to using regulation are that revenues will decrease as consumption drops and some users may oppose limitations on how they can use their water.

Education - Education programs can help any conservation program because education is generally well received by the public and can reduce user opposition to other programs. It is effective for any goal, except long-term, high percentage reduction goals.

The major disadvantages to education are that revenues may decrease as consumption decreases, and results are less reliable than other programs because of its voluntary nature.

Impacts

The types of impacts for demand management programs include:

- What a change in revenues, up or down, will mean to the utility or company;
- How a change in water rates might affect high volume users, including potential impact on employment;
- What the effect of reduced water use, such as reduced wastewater treatment costs, postponing new source development, potential damage to landscaping, and increasing the potential for adding new connections, will have on the utility or company;
- How the public will react to the conservation program, and to the perceived equity of the program;
- What it will cost to implement the program; and
- How laws, regulations, or ordinances create or limit options.

Figures 3.4 - 3.7 in the handbook detail most of the impacts of demand management programs.

You are cautioned that the implications and impacts of combining demand management programs are not additive, typically. It may be difficult, for example, to know the relative savings of water to expect from both restrictions on water use and a water rate increase.

STEP 4, IDENTIFY ACTIONS TO MODIFY ADVERSE IMPACTS

In Step 3 you identified the impacts of various supply and demand management approaches. In Step 4 you identify actions which can minimize the adverse impacts associated with each program, and then choose the best program.

Figures 4.1 and 4.2 in your handbooks list potential actions you could take to minimize these adverse impacts.

STEP 5, CHOOSE SPECIFIC SUPPLY AND/OR DEMAND MANAGEMENT PROGRAMS

Step 5 is the place to begin detailing the specific elements of a conservation program.

Once you have analyzed the cost-effectiveness, impacts, and modifications of the impacts of supply management programs, you'll be able to select programs most effective for your community. Review each supply management program again to be sure that it has the potential to achieve the conservation goal you have established. This step is much more involved for demand management.

After you've completed the analyses in Steps 3 and 4, choose the programs that are the most cost effective and have most beneficial impacts. Step 5 is the place to begin detailing the specific elements of a conservation program. On the demand side, this includes:

Pricing: establishing a new water rate

Regulation: choosing water use restrictions

Education: choosing education tools/devices/campaign materials

Pricing - There are two aspects of a pricing policy: the price level (price per unit) and price structure (price level variations based on time, quantity and/or type of use).

Price level is more important because only when the price level is high enough -- regardless of structure -- will users consider how they are using water and conserve.

There are six basic steps for designing a new water rate.

A. Determine the goal for percent reduction; for example, 5% or 10%.

B. Estimate the decrease in water use by consumers in response to price increases. This change is termed "price elasticity of demand."

C. Determine the percent change of price necessary to achieve your goal.

D. Calculate the new total revenue, as a result of the new price.

E. Compare the new total revenues to your annual costs (remember, variable costs will drop as water use drops).

- if revenues too high, may need a lower price
- if revenues too low, may need a higher price
- a price structure can change your revenues up or down

F. Select a price structure - price structures are used to modify price levels so that the total water rate (level and structure) can achieve one or more of the following:

- cover the true cost of supplying water
- be equitable to all users
- be easily understood and accepted by consumers
- discourage waste of water and subsidization of consumption of one user group by another
- be politically acceptable.

Twenty common price structures are listed in Figure 5.2 in your handbook. They are grouped by their ability to meet peak or average conservation goals. Like the other charts, use it as a resource to pick a structure that meets your goal.

When using pricing there are several guidelines to keep in mind:

- responses to a price hike generally diminish as users become accustomed to them;
- pricing is most effective in reducing peak use among residential users and average use among large volume users;
- in the Great Plains, the price of water has been traditionally low and responsiveness to price hikes is generally low, especially among residential users;
- changing a water rate often requires a long lead time;
- only propose a water conservation price hike once -- or community opposition may develop.

PREDICTING RESPONSE TO PRICING

It will be useful at this point to elaborate on this concept. Price elasticity of demand is defined as follows:

$$\text{Elasticity Value} = \frac{\% \text{ change in water use}}{\% \text{ change in price}}$$

The Elasticity Value is the way that economists measure individuals' response to price changes. Every individual and every community will respond differently.

Let's consider briefly how you would use elasticity to forecast user response in Shortfall. Suppose you decided to raise the price of water in Shortfall by 10% to residential

users. The following formula can be used to determine the decrease in water use:

$$\% \text{ change in water use} = \text{Elasticity Value} \times \% \text{ change in price}$$

$$= -.40 \times 10\% = -4\%$$

or conversely, suppose that you decided you needed to determine the price necessary to reduce residential water use by 10%. The correct formula is:

$$\% \text{ change in price} = \frac{\% \text{ change in water use}}{\text{Elasticity Value}}$$

$$= \frac{-10\%}{-.40} = 25\%$$

A 25% increase in price is necessary to reduce consumption by 10%. A detailed discussion of these calculations is available in the handbook.

The Elasticity Value can range from zero to $-\infty$. It is negative because the price of water and water use move in opposite directions. For water, some typical Elasticity Values are:

	Range
Total residential use	-.05 to - .45
Indoor use	-.07 to - .30
Outdoor use	-.22 to -1.57
Total Commercial/Industrial use	-.56 to -1.33

The more responsive water is to a change in price, the more negative the elasticity. For example, outdoor use is more responsive (more elastic) than indoor use. Conversely, indoor use is less responsive (less elastic) than outdoor use.

There are many factors which influence the price elasticity of demand for water. Some of the important ones are:

Amount of price increase: the larger the increase, the greater the response

Average user income: the higher the income, the less the response

Price level: the higher the price level, the greater the response on the part of users

Average number of people per household: the larger the number, the less the response

Average rainfall and temperature: the more temperate the climate, the less the response

In the case study, the elasticity values were assumed to be as follows:

Shortfall Elasticities

Residential	-.40
Commercial & Municipal	-.70
Industrial	-1.30
All Users	-.46
Summer	-.80
Winter	-.13

The elasticity values in your community will be within these same ranges. As a utility manager you will have to estimate your elasticity values after evaluating the factors which influence price elasticity. For example, if your community had a relatively low user income and an arid climate, you could expect that the demand would be relatively elastic.

Regulation - Choose a regulation program from the following methods:

- restricting a specific water use
- restricting the time/season during which a specific use is allowed
- requiring permits for some water users
- restricting the quantity of water which can be used
- requiring appliances and equipment which use a smaller amount of water

Various regulations have different potentials for meeting conservation goals.

Another illustration (figure 5.4) in your handbook summarizes these potentials.

Keep in mind that some regulations may be prohibited in your community. In other cases, regulations may require enforcement you are not able to provide, e.g., limiting a new specific use. Finally, some regulations, such as rationing or plumbing code changes, may not be effective because of user or political opposition.

Practical experience has yielded several recommendations:

- reserve stringent regulations, such as rationing and use bans, to high percentage reduction, short-term goals, and to periods of extreme emergency, such as extended drought;
- use less stringent regulations, such as plumbing code changes and limits on specific uses, for long-term, low percentage goals;
- most regulations that limit outdoor uses are easy to implement and can achieve water use reductions immediately;
- all regulations require some level of enforcement -- make sure enforcement staff is available.

Education - Education can stand on its own, or augment price and regulation programs.

The number of educational tools are many -- it is important to match the right educational tools and techniques to your community setting.

Each available tool is bound by two factors:

- type of community
- budget resources

Another illustration in your handbook (figure 5.5) presents a partial list of educational methods used to encourage water use reduction.

Some are better suited to small communities than large; some are more expensive than others.

If you are a technical person you may wish to work with communications professionals when developing educational programs. The assistance of a local newspaper editor or public relations practitioner can help yield a better, more focused program.

Past experience has provided some education-related recommendations:

- Educational programs should help users to understand why conservation is needed and should provide specific recommendations on how to conserve.
- Education is most effective during a water crisis when user awareness is high.
- Keep conservation messages short and simple.
- Provide detailed data on how to reduce consumption after getting people's attention.
- Mix the media. Use visuals to strengthen claims or message. People remember pictures better than words.
- Reach as many consumers as possible with as many techniques as possible, budget allowing.
- Users need constant reminders of the need to conserve.
- School programs are sometimes successful when children teach their parents/siblings water-saving habits.

All three of the demand side strategies - pricing, regulation, and education - require the utility to forecast the impact of the selected program on the amount of water conserved. This is particularly difficult for pricing strategy. As indicated before, the response of water consumers to a change in price is measured by the "price elasticity of demand."

STEP 6, CHOOSE SPECIFIC HARDWARE AND TECHNIQUES

In this step, you select techniques that will reduce water use in your community.

For supply management the specific hardware/techniques will depend on your individual system and preference. For example, for metering, you will have to choose the type of meter for installation and design a meter replacement/maintenance schedule. For leak detection and repair, you will have to choose a system survey method. For example, you will have to choose between aquaphones, geophones, or electronic surveys for leak detection. For pressure reduction, you will need to select the brand and size of the pressure reducing valves. Continue this exercise for the other supply management options.

Now let's return to the analysis of demand management programs.

There are three categories of hardware/techniques for Demand Management Programs:

- water saving fixtures
- reuse/recycle systems
- user habit changes

Again, you need to review each technique to determine which is most applicable to your community.

Water Saving Fixtures:

They reduce water use by modifying the design of a conventional plumbing system.

Water-saving fixtures, recommended:

- should be approximately equal to conventional fixtures
- should not require excessive maintenance
- should reduce water use significantly
- should gain easy acceptance by consumers

There are many types of water-saving fixtures. Of more than 50 different types, the 20 most cost-effective fixtures are detailed in a Figure 6.2 in your handbook.

Reuse/Recycle Systems:

They reduce water use by using the same water more than once. They are best for long-term, high percentage goals.

Reuse: Using the same water for more than one function with little or no treatment prior to discharge.

Recycle: Using the same water repeatedly, usually with some treatment.

They are generally:

- very effective
- very expensive

Figure 6.4 in your handbook details the eight situations in which reuse/recycle systems are used most.

User Habit Changes

User habit changes are designed to reduce water use by changing the user's behavior pattern. They are best for long-term, low percentage, and short-term, high percentage goals.

There are two basic behavior pattern changes:

- use less water to perform the same function
- perform the function less often

Developing a long-term or short-term education program is the key to affecting user habit changes:

- users need information before they change their routine behavior
- users need constant reminders and reinforcement if user habit changes are to continue.

Figure 6.5 in your handbook matches some habit changes with conservation goals.

STEP 7, SUMMARIZE CONSERVATION PLAN

To summarize your conservation plan, draw together the results of the prior steps.

GOALS:

SUPPLY MANAGEMENT: HARDWARE AND TECHNIQUES

DEMAND MANAGEMENT: HARDWARE AND TECHNIQUES

PRACTICE EXERCISE:

Case Study Community

Instructions for Exercise

CASE STUDY: SHORTFALL, MONEKOTA

Shortfall is a small city of 7,500 people, located next to an intermittent stream, Corn Creek, in cental Monekota. The population has been relatively stable for quite some time, and significant new growth is not expected. All of the people are served by a central water supply system that was built in the 1930's. Ninety percent (90%) of the services are metered; the major exception being the older central part of the city. This part of the service area is a mix of residential, commercial, and municipal users. Water pressure is fairly even throughout the city, at about 60 pounds per square inch. The water utility has maintained the system consistently over the years, and it is in generally fair condition. However, in the past few years, the budget has been very tight and some programs such as regular leak detection and repair, main relining, and valve checks and maintenance have had to be dropped.

The source of supply is a series of five wells in the northwest corner of town. These wells all draw water from the same aquifer. The combined safe yield of these wells (safe yield is defined for this case study as the amount of water which can be annually withdrawn without permanent or long-term depletion of the source) is 432 million gallons per year (mgy), or an annual average of 1.2 million gallons per day (mgd). The supply just meets the annual average demand of 1.2 mgd of the city. The

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wells are designed to be pumped at higher than average rates during peak use periods. In the summer, when peak use is highest, the utility pumps water from the wells to the storage tank on off-peak hours. The stored water is then used during peak hours. With this pumping schedule, the utility can meet the average summer daily demand of 1.7 mgd (212 mgy). The average winter daily demand of .9 mgd (220 mgy) is easily met without special pumping schedules.

The major water use categories are as follows:

Residential (1875 connections)	--	342 mgy (.95 mgd)	79%
Commercial (and some municipal, 60 connections)	--	18 mgy (.05 mgd)	4%
Industrial (1 connection)	--	20 mgy (.05 mgd)	4%
Unaccounted-for water	--	52 mgy (.15 mgd)	13%
TOTAL	--	432 mgy (1.2 mgd)	

The city serves as the agricultural supply and trade center for the area. The one industrial connection in town is a long established cheese processing plant that employs a significant portion of Shortfall's residents.

Over the past few years, agricultural users outside the city limits have significantly increased their withdrawal of water from the same aquifer that the city wells tap. This large increase in use has caused a slow decline in ground water levels,

reducing reliable safe yields, and increasing water quality problems. A new treatment plant is now needed in Shortfall to treat the well water so that it remains usable. The city has not been able to convince large agricultural users to reduce their water use to slow the rate of groundwater level decline.

The water utility is municipally owned, but it operates as a separate entity. The city council oversees the entire operation: the council must approve the budget, major projects, and rate increases. As a separate entity, the utility must meet all its own expenses through the sale of water. Traditionally, it has not been subsidized by the city, except under very extreme conditions. However, it also cannot make large profits because it ultimately has to answer to the city council which does not believe that large profits are in the public interest. Recently, the council reluctantly approved a rate increase to meet the expenses of the construction of the new treatment plant. The rate is now a uniform unit rate of $.75 per 1000 gallons. This rate generates enough revenue to meet the annual costs of $285,000 to run the utility. (The $285,000 budget includes the new debt on the bond issues floated to pay for the treatment plant). The annual costs are broken down as follows:

FIXED COSTS	--	$190,000
VARIABLE COSTS	--	$ 95,000 (or $.25/1000 gallons produced)
TOTAL	--	$285,000

For the past few years, the entire region has suffered from a severe drought. This shortage of rainfall has made the utility's problems worse. Peak use during the summer has been higher than usual as people have used more water to compensate for the lack of rain. Recharge to the groundwater has been reduced and groundwater levels are declining faster than "normal" as a result. The utility expects the groundwater levels to drop even further since the recovery of groundwater from the effects of a drought is very slow. Even if rainfall is normal this year, water levels will probably not recover sufficiently, nor be high enough to meet demand.

The water superintendent presented the current supply situation to the city council. They were concerned about the economic effects of the drought and authorized the superintendent to look for a new source of water. The initial search was disappointing. No other aquifer in the area is large enough to tap for public use; the aquifer that is currently tapped cannot withstand another well or deeper wells because it is already being over used. Purchasing water from adjacent users is not likely because they too are experiencing drought conditions and declining groundwater levels. In addition, distances are great, making water connections prohibitively expensive. Developing a reservoir at Corn Creek is a possibility. However, the initial analysis showed that the yield would be small, less than .25 mgd, and it would not be dependable during a severe drought because of the intermittent nature of the river flow. The cost of develop-

ing a reservoir would be in the millions of dollars. An additional rate hike of 100% would be necessary to pay for reservoir construction. This option is politically unacceptable to the city council because they just approved a rate hike to pay for the water treatment plant.

The water superintendent feels that something must be done immediately to cope with the drought situation and the long-term projected decrease in yields from the wells. The superintendent estimates that the reliable safe yield of the wells, given that they are overpumped and that the rainfall/recharge estimates are lower now than when the system was designed, is really only 1.0 mgd, or 15% (65 mgy) short of the average annual demand.

EXERCISE INSTRUCTIONS

STEP ONE: IDENTIFY PROBLEM/ESTABLISH GOAL

Read the case study describing conditions in Shortfall, Monekota.

A. Review with your group the water supply problems Shortfall is experiencing. Identify the most critical problems faced by your utility as a whole. On the card marked "PROBLEM" on the exercise sheet for STEP ONE, write down the problems, in order of priority, that your group considers most critical.

B. The conservation goal is defined by three factors. Discuss as a group whether the supply/demand problems faced by your utility are:

1. HIGH percentage (10% and above) supply-demand deficit, or LOW percentage (less than 10%) supply-demand deficit.

2. LONG-TERM (one year or more), or SHORT-TERM (less than one year).

3. AVERAGE USE or PEAK USE must be reduced.

On the exercise board for STEP ONE are three cards which list the factors described above. Place a check next to those factors your group feels best define your conservation goal.

C. As you develop the conservation goal needed to solve the problems faced by your utility, also consider whether these problems could be solved more effectively on a county-wide scale. Traditionally, water users in this part of the state have attempted to solve their water deficit problems independently. As the problems have become more widespread, solutions have become more complex. Coordinated programs among utilities may be one alternative method of solving a regional problem effectively.

D. Finally, discuss the criteria your group would select to evaluate the success of your plan, once implemented. Among the criteria which you may wish to consider are those concerned with effectiveness, efficiency, enforceability, and equity. Write down on the criteria card the criteria your group chooses to apply to your program. Place this card above the boxes marked "GOAL" on the exercise board.

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STEP TWO: ASSESS POTENTIAL OF SUPPLY MANAGEMENT

Supply management programs are implemented to improve the efficiency of production and delivery systems. Therefore, it is recommended that these programs be considered first. If they are capable of meeting the conservation goal, then you will not have to require homeowners and businesses to reduce demand.

As a group, discuss the costs and water savings for the supply management programs described on the cards marked "SUPPLY MANAGEMENT" in STEP THREE of the exercise board. Determine if the potential to use supply management to solve the problem completely or in part is high or low. If the potential for supply management is high, then move to STEP THREE and evaluate supply management programs in detail. If the potential for supply management is low, move to STEP THREE and evaluate how the problem can be solved with demand management programs.

Review the existing conditions of your utility:

- Can the utility afford a supply management program?
- If the utility cannot afford a supply management program, can it obtain extra funds to pay for the program?
- If supply management were implemented, would there be any opposition from the users or other local interest groups?
- Will there be enough time to carry out the programs to meet the conservation goal within a reasonable time?

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STEP THREE: ANALYZE NET COST OF MANAGEMENT PROGRAMS

Two stacks of cards marked "SUPPLY MANAGEMENT" and "DEMAND MANAGEMENT" detail a variety of conservation programs that could be used by your utility. For each conservation program, the cards contain information on the following:

1. a description of the program;

2. the estimated annual average water savings; and

3. the estimated annual net average costs to implement the program (NOTE: cost figures include indirect costs such as impact on utility revenues, as well as direct costs of the program.) Any of the programs could be implemented either way.

Review with your group all the SUPPLY MANAGEMENT programs if supply management was determined to have high potential in STEP TWO. Review all DEMAND MANAGEMENT programs if supply management was determined to have low potential.

Remember, you can combine any program from SUPPLY MANAGEMENT with any other program from SUPPLY or DEMAND management by simply adding the water saving and net cost figures together to get the totals. However, when combining DEMAND MANAGEMENT programs together, you must consider the interactive effects of the two programs. For instance, if an education program designed to reduce outdoor use and a pricing program designed to reduce outdoor use were implemented at the same time, they would be influencing the same water use. Users would respond to both programs by doing one thing -- reducing peak use. Therefore, although more people will respond to the combined program, their individual response will not double. The water savings and costs figures of combination demand management programs have been estimated and are described on the cards in the DEMAND MANAGEMENT stack.

NOTE: You can choose only one option within a management program category; i.e. one Leak Detection and Repair Program, one Education Program, one Pricing program.

If there are any other programs you feel are more appropriate than those described, use the blank cards at the bottom of the stacks to design your own program, including water savings and costs.

Place the cards which describe the programs your group decided are most appropriate for Shortfall and place them in the boxes on the exercise board under STEP THREE.

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STEP FOUR: ANALYZE IMPACTS AND MODIFICATIONS TO ADVERSE IMPACTS OF MANAGEMENT PROGRAMS

After selecting a preliminary set of management programs that are cost-effective, analyze the social, political, and legal-institutional impacts of these programs.

From the two stacks of cards marked "SUPPLY MANAGEMENT" and "DEMAND MANAGEMENT", choose those cards that match the programs you selected in Step Three and place them on the exercise sheets.

Review the impacts and modifications for the adverse impacts that are listed on each card. Discuss the impacts and modifications with the group and determine whether the preliminary set of programs is still acceptable. If so, make any appropriate modifications to the preliminary set of programs suggested by the modifications - of any other modifications you may feel are important. Put a check by those modifications you are willing to make, or that apply.

If the preliminary programs are unacceptable, return to STEP THREE and re-analyze the options.

NOTE: If there are any impacts that you feel must be considered that are not listed on the cards, write them in the blank spaces on each card. Or - if you designed your own programs, use the blank impact cards at the bottom of the stacks to describe their impacts and necessary modifications.

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STEP FIVE: CHOOSE COST EFFECTIVE MANAGEMENT PROGRAMS

In STEP THREE, you evaluated the net cost of various management programs. In STEP FOUR, you evaluated the impacts of the programs. Based upon this analysis, choose the programs that most effectively meet your conservation goal and which have the fewest adverse impacts and most desirable cost to impact ratio. Take the cards that describe these programs from STEP THREE and place them in the boxes in STEP FIVE.

Review the programs to make sure the conservation goal is met. If not, return to STEP THREE.

The MANAGEMENT PROGRAMS are one part of your draft water conservation plan.

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STEP SIX: CHOOSE SPECIFIC HARDWARE/TECHNIQUES

For SUPPLY MANAGEMENT you would have to select the specific type of retrofitting and other equipment you need or determine exactly who would be carrying out the work. This will not be done for this exercise.

For DEMAND MANAGEMENT, there are three groups of hardware/techniques that reduce water use in homes and businesses.

1. Water-saving fixtures;
2. Reuse/recycle systems; and
3. User habit changes.

Even though the purchase and installation of hardware, or the implementation of user habit changes is up to the homeowner or businessperson, you may want to assist them in their efforts to reduce water use. Many utilities have found that permanent use reductions are more likely to occur if the water supplier takes an active role in this phase of the program. Frequently, users do not purchase the best equipment, or do not take the actions that will best achieve a conservation goal. Therefore, use reductions might diminish over time unless you provide guidance on the implementation of hardware/techniques.

Review with the group the cards marked "HARDWARE/TECHNIQUES" and discuss if the utility should take an active role in this phase of the program. The cards for STEP SIX describe six levels of activity. Choose the level that best meets your program needs. Place the card that matches your choice on the exercise sheet for STEP SIX.

If none of the activities meet your needs, develop your own, including the cost per user.

The HARDWARE/TECHNIQUES are the second part of your draft conservation plan.

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STEP SEVEN: SUMMARIZE CONSERVATION PLAN

As a group, review the draft conservation plan you designed in STEPS FIVE and SIX. Make sure that: 1) the plan can effectively meet the conservation goal, 2) the adverse impacts associated with each program will not make the program unacceptable, and 3) all the elements of the plan (PROGRAMS, HARDWARE/TECHNIQUES) are well coordinated.

If all of the above conditions are met, and the program meets your criteria established in STEP ONE, then your draft plan will be your final plan.

If any of these conditions are not met, return to STEPS THREE and SIX and reconsider the MANAGEMENT PROGRAMS and HARDWARE/TECHNIQUES.

As a final exercise consider the major elements of your plan strategy. What are the specific program element(s) on which the success of your effort largely rests? Suppose that the community, utility commission or others refuse to approve these or other elements. What special efforts would you then undertake, or what contingency plan do you envision as a compromise?

Finally, choose a spokesperson who can present your plan to the entire group.

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OTHER RESOURCES:

Local Water Conservation Planning Worksheet

Technical Assistance in Designing a Water Conservation Plan

Bibliography

Notes on Price Elasticity

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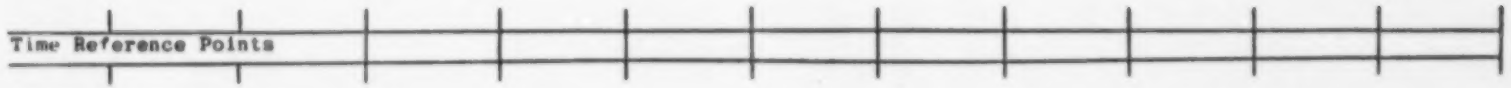
LOCAL WATER CONSERVATION PLANNING WORKSHEET

Name of Community or Utility _____

Nature of Water Problem:	Programs Most Likely to be in Conservation Plan: Supply (or system) Management:
Objectives of Conservation (or Drought Management) Effort:	
Criteria for a Successful Plan:	Demand Management:
Available Local Resources:	
Critical Constraints or Barriers:	

CONSERVATION PLANNING TIMELINE

Supply Management Programs



Demand Management Programs

TECHNICAL ASSISTANCE IN DESIGNING A WATER CONSERVATION PLAN

I. Assistance with using the seven-step planning approach:

Missouri Basin States Association
10050 Regency Circle, Suite 515
Omaha, NE 68114
(402) 397-5714

Barry Lawson Associates
190 High Street
Boston, MA 02110
(617) 451-3600

II. Assistance with preparing water conservation plans and general information:

Colorado

Richard Karlin
Colorado Department of Health
4210 East 11th Avenue
Denver, CO 80220
(303) 320-8333, ext. 3453

Dr. Jeris Danielson
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1313 Sherman Street, 8th Floor
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U.S. Environmental Protection Agency, Region VII
324 East 11th Street
Kansas City, MO 64106
(816) 374-6401

Water Division
U.S. Environmental Protection Agency, Region VIII
1860 Lincoln Street
Denver, CO 80295
(303) 837-4871

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NOTES ON PRICE ELASTICITY

The Elasticity Value has an important relationship to the change in a water utility's total revenue caused by a price change. For relatively small changes in price the following relationships hold:

- if the Elasticity Value is larger than -1, a price increase will increase total revenue
- if the Elasticity Value is smaller than -1, a price increase will decrease total revenue.

Because of this relationship the following terms are used:

- if the Elasticity Value is greater than -1, water use is said to be <u>inelastic</u>.
- if the Elasticity Value is less than -1, water use is said to be <u>elastic</u>.

Most, but not all, water use elasticity values are in the inelastic range (-1 to 0).

Let's illustrate the use of the Elasticity Value for determining the conservation, revenue and cost impacts of pricing strategy.

<u>Pricing Example</u>

Consider the following information about a water utility:

1. Budget:

Revenue		Cost	
Revenue	500,000	Fixed Cost	400,000
		Variable Cost	100,000
Total Revenue	500,000	Total Cost	500,000
Net Revenue	0		

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2. Rate Level and Structure:

Uniform unit rate of $1.00/1000 gallons

3. Water Deliveries:

500 mgy.

4. Average variable cost:

$.20 per 1000 gallons

5. Conservation Goal:

5% reduction in water deliveries.

6. Elasticity Value:

-.2

7. Calculation of required price:

$$\text{\% change in price} = \frac{\text{\% change in water use}}{\text{Elasticity Value}}$$

$$= \frac{-5\%}{-.2}$$

$$= 25\%$$

New price = old price + 25% of old price

= $1.00 + $.25 = $1.25

8. Calculation of new water use

New water use = old water use - 5% old water use

= 500 mgy - 25 mgy = 475 mgy

9. Calculation of new revenue:

New revenue = new water use x new price

= 475 MGY x $1.25/1000 gal = $593,750

10. Calculation of new cost:

New fixed cost = old fixed cost

= $400,000

New variable cost = Average variable cost x new water use

= $.20/1000 gallons x 475 mgy

= $95,000

New total cost = New fixed cost & variable cost

= $400,000 + $95,000 = $495,000

11. Calculation of new net revenue:

New net revenue = new total revenue - new total cost

= $593,750 - $495,000

= $98,750

Note the following impacts:

1. Total cost decreased because of the reduction of variable cost
2. Total revenue increased because the Elasticity Value is inelastic.

EXAMPLE UTILITY

	Pre Policy	Pricing	Regulation or Education	Pricing and Regulation Combined
Water Consumption (mgy)	500	475	475	475
Cost of Policy ($)	0	0	0	0
Fixed Cost ($)	400,000	400,000	400,000	400,000
Variable Cost ($)	100,000	95,000	95,000	95,000
Total Cost ($)	500,000	495,000	495,000	495,000
Total Revenue ($)	500,000	593,750	475,000	498,750
Net Revenue ($)	0	98,750	-20,000	3,750

Regulation Example

1. New Total Revenue = old price x new quantity
   = $1.00/1000 gal x 475 mgy
   = $475,000

2. New total cost = $495,000 (Same as pricing case)

3. New net revenue = new total revenue - new total cost
   = $475,000 - $495,000
   = - $20,000

Note the following changes from the impacts of the pricing example:

1. The utility is now making a net loss.
2. The costs of delivery are the same.